# Low Cost Discone Antenna

## *Wideband coverage from 144 to 1296 MHz.*

by Phil Salas AD5X

I needed an antenna that would satisfy a lot of needs. After purchasing an ICOM R-7000 receiver (25–2000 MHz) for some experimental work in the UHF and low microwave ham bands, I wanted a good broadband antenna that I could easily mount in my attic and that would provide coverage of the 144, 220, 450, 903, and 1296 MHz ham bands. I also needed this antenna to provide a good match so that it could be used for transmitting within these ham bands as well. Though this sounds like I'm asking a lot, there is a broadband antenna that can satisfy these needs: the discone antenna.

### The Discone Antenna

When properly designed, a discone antenna provides decade (10:1) frequency coverage with a good match (see Figure 1). The discone consists of a disk (the driven element) mounted over a conical ground plane. The cone is an equilateral triangle whose dimensions are a quarter wavelength at the lowest operating frequency. The disk (driven element) has a diameter of 70% of a quarter wavelength at the lowest operating frequency. The disk should be very close to the apex of the cone; the recommended spacing is from 10–30% of the diameter of the apex of the cone.

The trick is to be able to easily realize the cone and disk as well as provide a solid insulated support for the disk and a sound mounting method for the overall antenna. Also, this antenna should be inexpensive, and easily constructed with readily available

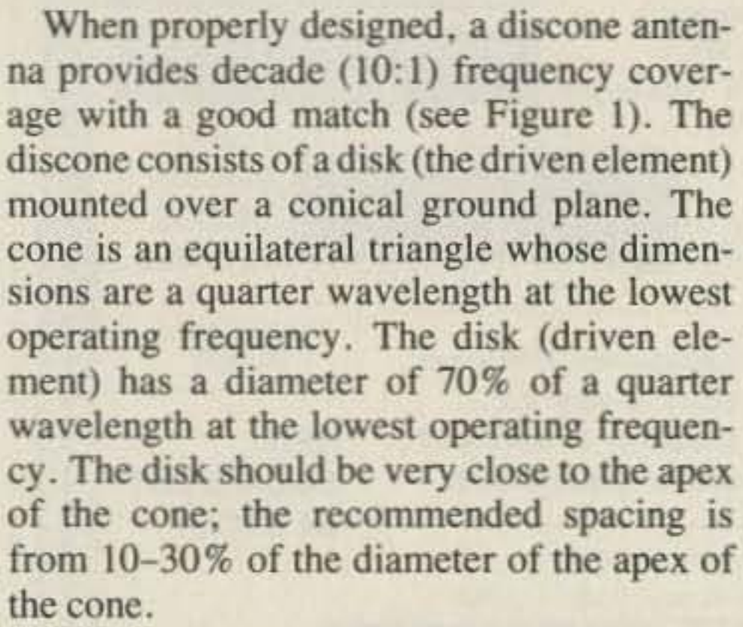


*Figure 1. Design for the discone antenna.*


*Figure 2. Dimensions of the disk support.*

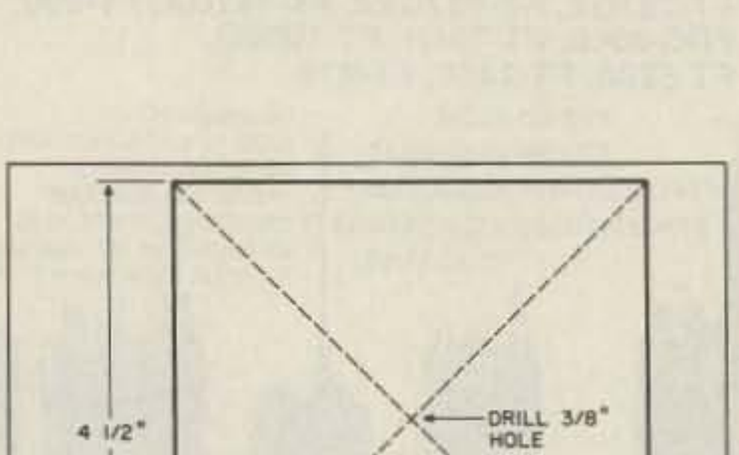


*Figure 3. Disk support preparation.*

parts from hardware and Radio Shack stores.

Since I wanted to cover the two meter band, I picked the lower frequency limit to be below the lower band edge. The actual frequency I picked was 137 MHz. A decade of coverage should still give me up to 1370 MHz, which suited my needs. The equation for this is: ¼ wavelength = 2952/137 = 21.5″ = cone side; disk diameter = 0.7 x 21.5″ = 15″.

Now all I had to do was figure out how to build it!

### Constructing the Discone

See the "Parts List." The last three items came from Radio Shack. The ⅜″ solder lugs are part of the package (two per package) of solder lugs from Radio Shack, but you can save money if you can find ⅜″ solder lugs separately. I bought all of the other items in the electrical department of a local hardware store.

Now, let's get to work. We will first prepare all the individual pieces.

The disk support will be made out of the single-sided printed circuit board. First, cut this board into a 4½″ x 4½″ square. With a pencil, draw diagonal lines from corner to corner on one side. See Figure 2. Drill a ⅜″ diameter hole at the intersection of the lines (the center of the PC board). Referring to Figure 3, center a quarter over the hole on the foil side of the PC board and trace around its circumference. Using a sharp X-ACTO™ knife, cut through the copper on the circular lines just traced. Now remove the copper *within* the circle. A soldering gun will aid in removing the copper foil.

The light fixture canopy needs some modification. These kits include a fixture for mounting a lamp on, a short length of 1/8IP threaded steel lamp pipe, and some additional hardware. Refer to Figure 4. Nibble or cut a slot along one side of the canopy at least 0.3″ x 0.3″. This will pass the coaxial cable when the canopy and antenna are mounted.

Cut all eight welding rods to a length of 21.5″. Unless you have heavy cutters, you will need to use a hacksaw. Remove any insulation from the ⅜″ solder lugs, insert only one end of the cut welding rods into the solder lug crimp end, crimp the lug and solder. See Figure 5.

Cut the remaining eight short pieces of welding rods to 7¼″. Finally, determine the center of the 4″ round plastic electrical box cover and drill a ⅜″ hole. It is important that this hole be well-centered, so take care in determining this location.

Now take the 30″ 1/8IP all-thread steel lamp pipe and carefully tin one end of the pipe. See Figure 6. Be careful not to get solder on the threads of the pipe. This pipe is

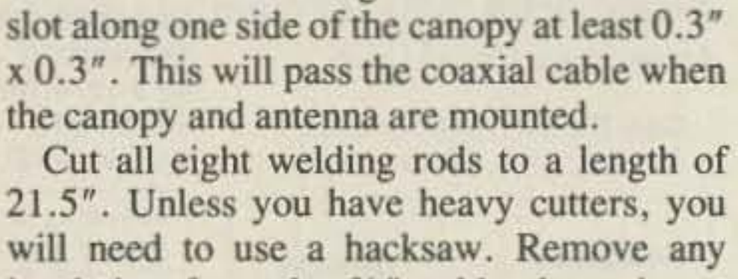


*Figure 4. Modifying the light fixture canopy.*

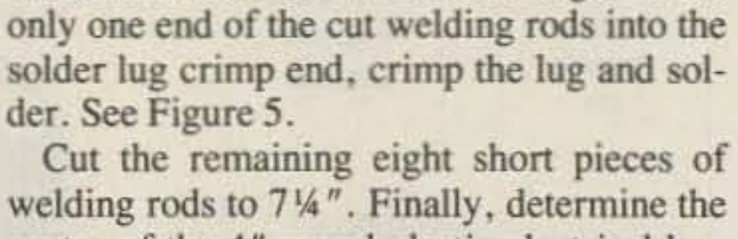


*Figure 5. Element preparation.*

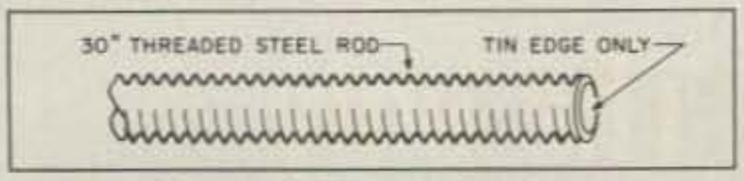


*Figure 6. Tinning the pipe.*

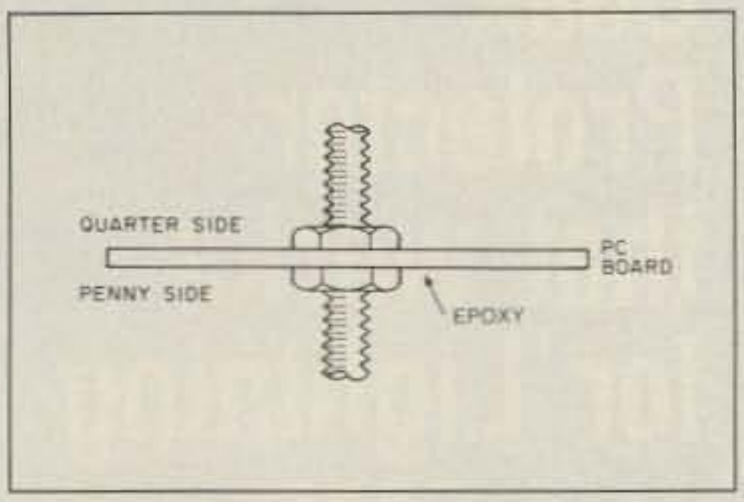


*Figure 7. Disk support assembly.*

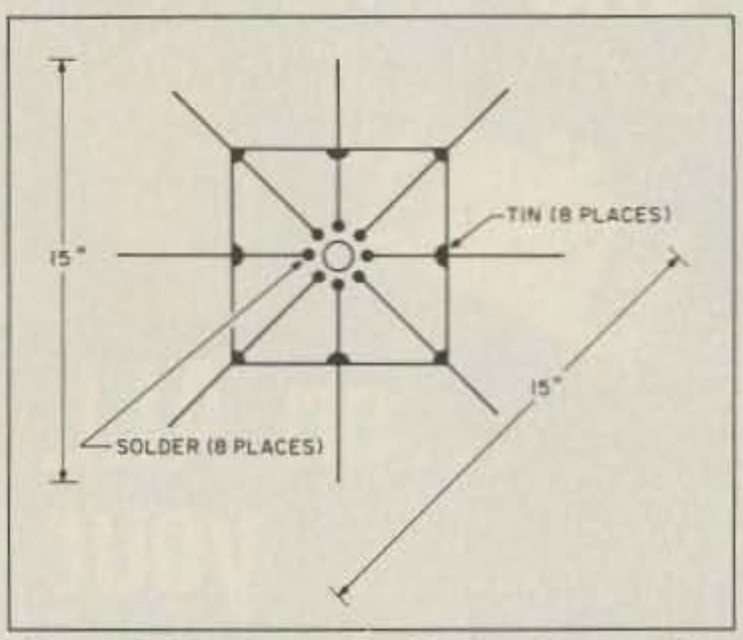


*Figure 8. Tinning and soldering the top of the PC board.*

not difficult to tin since it is made of steel, which doesn't conduct heat away as fast as copper or brass does. Cut 1" of the outer insulation off the RG-8M coaxial cable, separate the braid, and then fold it back over the cable insulation. Insert this end of the RG-8M cable into the non-tinned end of the 30" lamp pipe and push the cable through until the braid is flush with the tinned end of the pipe. Solder the braid to the pipe at this point.

Next, prepare the disk support printed circuit board. Insert a short length of steel lamp pipe (provided with the canopy kit) through the center hole in the printed circuit board and fasten it securely in place with two brass nuts. See Figure 7. Epoxy the brass nut to the PC board opposite the foil side. Be careful not to get epoxy on the threads. Now, remove the nut from the side of the board not epoxied, and unscrew the steel pipe from the nut still attached to the PC board. The side of the PC board with the nut will now be referred to as the bottom of the disk support PC board.

On the top of the PC board, tin each corner and tin the midpoint of each side. See Figure 8. Now solder down the 7¼" welding rods to the PC board, making sure that the total length from outer point to outer point is 15". You are creating a disk 15" in diameter out of the eight welding rods. Now go back and solder the inside edge of the welding rods to the PC board. Finally, place the 1" diameter brass washer over the ends of the welding rods centered over the hole in the PC board and solder the washer to the rods. See Figure 9.

Now it's time to start assembling the antenna. First, screw the end of the 30" pipe with the RG-8M center conductor sticking out into the nut on the bottom of the PC board. Screw it in just far enough so the end of the pipe is flush with the printed circuit side of the soldered down nut. The center conductor of the RG-8M will pass through the center of the brass washer on the top of the PC board.

Next, place the solder lugs of the eight long steel welding rods over the 30" steel pipe and hold them in place with a 1/8IP brass nut. Put this nut on finger-tight and then arrange each long rod so that it is exactly under each short rod on the top of the PC board. Carefully tighten the brass nut. Thread another brass nut on the steel pipe and position it about 3" below the nut holding the long rods in place. Hold the pipe upright with the PC board at the upper end, then bend all the long rods down along the steel pipe. Place the plastic electrical outlet cover over the steel pipe and thread on another brass nut. Push the electrical outlet cover up the pipe and spread the long welding rods until the bottom ends of the rods are 21.5" apart from their opposite rod. Adjust the nut positions as necessary and tighten the nuts to hold the electrical outlet cover in place. See Figure 10. I used a hot glue gun to attach the long welding rods to the plastic electrical outlet cover to help with the antenna rigidity, but this is not really necessary.

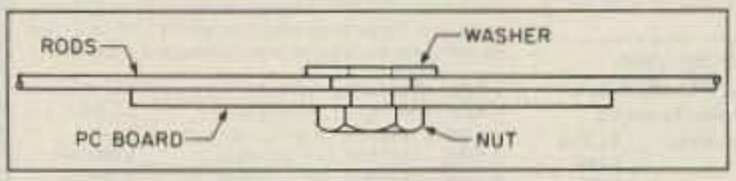


*Figure 9. Finishing the PC board.*

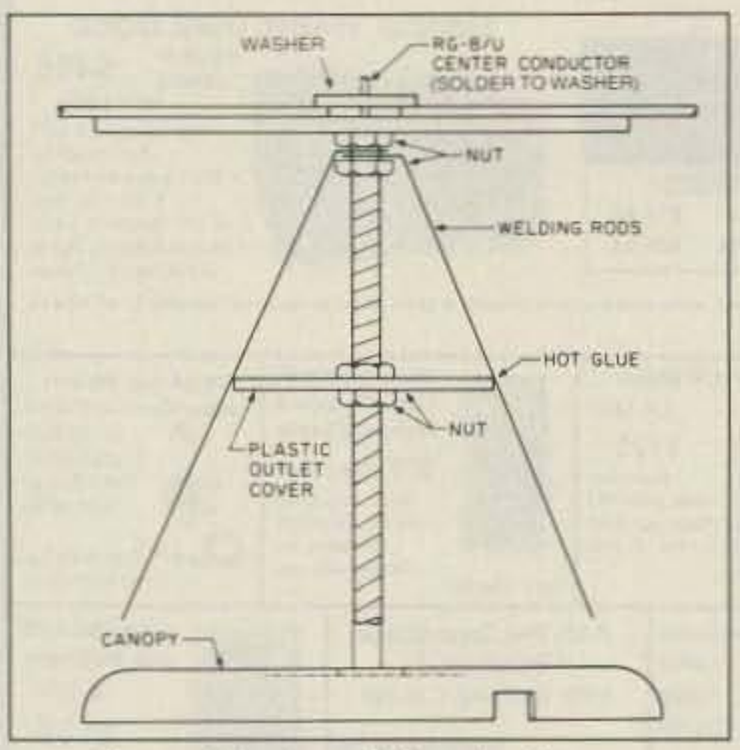


*Figure 10. Assembling the discone.*

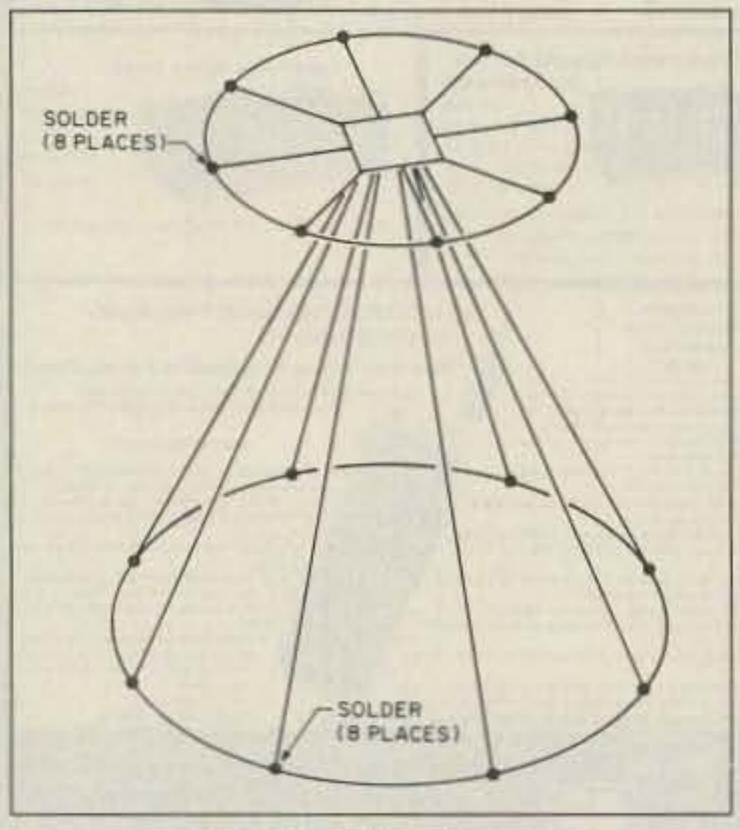


*Figure 11. Wire placement.*

**Parts List**

| Description | Approximate Cost |
|---|---|
| 1" diameter brass washer | $ .10 |
| 30" 1/8IP all-thread steel lamp pipe | $ 3.17 |
| 1 light fixture canopy kit | $ 2.45 |
| 6 brass 1/8IP nuts (pkg. of 6) | $ .99 |
| 1 plastic 4" round electrical box cover | $ .17 |
| 10 feet #12 copper wire ($.07/ft.) | $ .70 |
| 8 copper plated steel welding rods ($.20 ea.) | $ 1.60 |
| 12" x 24" x 1" piece of wood | $ 1.00 |
| 4½" x 4½" single-sided PC board | $ 3.99 |
| 6 ⅜" solder lugs (RS 64-3040 x 3) | $ 3.87 |
| 5 feet RG-8M (RS 278-1328 0.27 x 5) | $ 1.35 |
| Total | $19.39 |

The long welding rods to the plastic electrical outlet cover to help with the antenna rigidity, but this is not really necessary.

Strip the insulation off the RG-8M center conductor as it passes through the brass washer on the top of the printed circuit board. Solder the center conductor to the brass washer. Now, mount the antenna to the canopy by threading another brass nut over the end of the steel pipe, passing the cable and pipe through the hole in the canopy, and threading another nut over the pipe and tightening it. You can now attach the canopy to a piece of wood (I used a 1' x 1' x 1" board), thus allowing the antenna to stand freely.

The last thing to do is to solder a piece of #12 copper wire around the circumference of the disk and cone. Cut a 50" piece of wire for the disk and a 70" piece of wire for the base of the cone. Tin the ends of each of the welding rods and solder the copper wire to them. See Figure 11. Though it is not really necessary to tie all the welding rod ends together, this and the hot glue mentioned earlier make the antenna very rigid.

Finally, attach your connector of choice to the end of the RG-8M coming from the discone. RG-8M has the same dimensions as RG-59. A PL-259 UHF connector with a RG-59 reducer or a BNC connector for RG-59 cable work well.

### Operation

How does it work? I measured an SWR of less than 1.5 to 1 on all ham bands between 144 and 1296 MHz. I placed the antenna on its wood base in my attic and it provides excellent general coverage reception, as well as transmission in the covered ham bands. Not bad for about an hour's worth of work and less than $20 worth of parts! 73

*Contact Phil Salas AD5X at 1517 Creekside Drive, Richardson TX 75081.*